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(54) Title: POLYMER BLENDS CONTAINING PROPYLENE-ETHYLENE COPOLYMER AND ETHYLENE-ALKYL ACRYLATE COPOLYMER (57) Abstract Compositions are provided comprising a propylene-ethylene copolymer containing about 1 to about 7 weight percent ethylene and an ethylene-alkyl acrylate copolymer containing at least about 20 weight percent ethylene, wherein the composition contains about 10 to 25 weight percent alkyl acrylate, based on the combined weight of propylene-ethylene copolymer and ethylene-alkyl acrylate copolymer. Films made from these compositions have good RF scaling properties, as well as good flexibility at low temperatures.		

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01 POLYMER BLENDS CONTAINING PROPYLENE-ETHYLENE COPOLYMER
02 AND ETHYLENE-ALKYL ACRYLATE COPOLYMER
03

04 FIELD OF THE INVENTION
05

06 The present invention relates to polymer blends comprising a
07 propylene-ethylene copolymer and an ethylene-alkyl acrylate
08 copolymer.
09

10 BACKGROUND OF THE INVENTION
11

12 Polymer blends containing propylene polymers and ethylene
13 copolymers are known. For example, U. S. Patent
14 No. 3,433,573, issued March 18, 1969 to Holladay et al.,
15 discloses compositions containing blends of 5 to 95% by
16 weight of a propylene polymer containing a major amount of
17 propylene and 95 to 5% by weight of a copolymer of ethylene
18 with a polar monomer such as vinyl acetate, methyl
19 methacrylate, vinylidene carbonate, alkyl acrylates, vinyl
20 halides and vinylidene halides. However, the only ethylene
21 copolymer used in the examples is an ethylene-vinyl acetate
22 copolymer. These compositions are said to be useful in
23 fibers, films and molded articles of improved dyeability and
24 low temperature characteristics.

25
26 U. S. Patent No. 3,555,110, issued to McConnell et al. on
27 January 12, 1971, discloses that ethylene copolymers such as
28 ethylene/alkyl acrylate, ethylene/aryl acrylate and
29 ethylene/alkenyl carboxylate copolymers are compatible with
30 alpha-monoolefin block polymers such as propylene/ethylene
31 polymers having from about 50% to 99% by weight of
32 polypropylene segment in the polymer chain. Objects
33 prepared from these polymer blends are said to have
34

- 2 -

01 excellent clarity, improved low temperature properties and
02 good impact strength at low temperature.

03

04 U. S. Patent No. 4,774,277, issued on September 27, 1988 to
05 Janac et al., discloses compositions useful in the
06 preparation of film which is said to be soft and have high
07 tensile, tear and impact strength. The compositions contain
08 polyolefin plastics blended with an elastomeric plasticizer.
09 The disclosed polyolefin plastics are polypropylene,
10 polypropylene reactor copolymer, polybutylene, linear
11 low density polyethylene, high density polyethylene or
12 mixtures thereof. The elastomeric plasticizer contains
13 (1) polyethylene or a copolymer of ethylene and an
14 unsaturated ester of a lower carboxylic acid, (2) olefin
15 elastomer, such as copolymers of ethylene with higher
16 alpha-olefins such as propylene containing about 30-90
17 weight percent ethylene, and (3) a hydrocarbon oil.

18

19 U. S. Patent No. 4,835,218, issued May 30, 1989 to
20 Yoshimura et al., discloses a composition for shrinkable
21 film which is said to have good heat sealability,
22 transparency, strength, and low temperature quick shrinking
23 properties. The composition contains specific combinations
24 of (A), (B) and (C), i.e., the combinations of (A)+(B),
25 (B)+(C), and (A)+(B)+(C), wherein (A) is non-rigid
26 polyolefin resins such as ethylene-vinyl acetate, (B) is an
27 elastomer comprising a specific ethylene-alpha-olefin
28 copolymer and an elastomer consisting of block copolymer
29 having at least one monovinyl substituted aromatic
30 hydrocarbon polymer block and at least one polyolefin
31 polymer block selected from at least one saturated polymer
32 or unsaturated polymer made from mainly aliphatic conjugate
33 diene derivative, and (C) is rigid polyolefin resins such as
34 polypropylene.

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SUMMARY OF THE INVENTION

01

02

03 In accordance with the present invention, there is provided
04 a composition comprising:

05

06 A. a propylene-ethylene copolymer comprising about 1
07 to about 7 weight percent ethylene; and

08

09 B. an ethylene-alkyl acrylate copolymer comprising at
10 least about 20 weight percent alkyl acrylate,

11

12 wherein the percent by weight of alkyl acrylate, based on
13 the weight of A and B, is from about 10 to about 25.

14

15 Also provided in accordance with the present invention is a
16 film made from a composition comprising:

17

18 A. a propylene-ethylene copolymer comprising about 1
19 to about 7 weight percent ethylene; and

20

21 B. an ethylene-alkyl acrylate copolymer comprising at
22 least about 20 weight percent alkyl acrylate,

23

24 wherein the percent by weight of alkyl acrylate, based on
25 the weight of A and B, is from about 10 to about 25.

26

27 Among other factors, the present invention is based upon the
28 discovery that films made from the compositions of this
29 invention are RF sealable when a signal having about 27.2
30 MHz frequency, and about 1.1 KW/inch² power is applied for
31 about 1.5 seconds. In comparison, films made from the
32 propylene-ethylene copolymer alone will not RF seal.

33

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01 DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

02

03 The propylene-ethylene copolymers useful in the compositions
04 of this invention comprise copolymers of propylene and
05 ethylene in which the ethylene comprises about 1 to about 7,
06 preferably about 1 to about 5, more preferably about 2 to
07 about 2.5 weight percent of the copolymer, based on the
08 combined weight of propylene and ethylene. These propylene-
09 ethylene copolymers may also contain minor amounts of at
10 least one additional monomer, such as butene, though this
11 additional monomer(s) is not necessary.

12

13 The propylene-ethylene copolymers of this invention are
14 random copolymers. That is, the propylene and ethylene are
15 randomly distributed along the polymer chain, as opposed to
16 being present in block copolymer form.

17

18 Examples of the propylene-ethylene copolymers useful in this
19 invention include the copolymer designated SA861 having a
20 melt flow rate (as measured by ASTM D12386) of about 6 and
21 an ethylene content of about 2.2 weight percent, and the
22 copolymer designated KT011P, both of which are sold by
23 Himont Inc. The preferred propylene-ethylene copolymer is
24 SA861.

25

26 The ethylene-alkyl acrylate copolymers which form part of
27 the compositions of this invention are copolymers of
28 ethylene and one or more alkyl acrylates. Examples of the
29 alkyl acrylates include, but are not limited to, acrylic
30 esters of linear, branched or cyclic alcohols having 1-28
31 carbon atoms. The alkyl acrylate esters are exemplified by,
32 but not limited to, methyl acrylate, ethyl acrylate and
33 butyl acrylate, with methyl acrylate and butyl acrylate
34 being preferred.

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01 One preferred group of ethylene-ester copolymers are
02 ethylene-alkyl acrylate copolymers which have high melting
03 points. These ethylene-alkyl acrylate copolymers have an
04 alkyl acrylate content of X weight percent, X being 20 or
05 more and being based on the total weight of ethylene and
06 alkyl acrylate in the copolymer, the copolymer having an
07 average melt-point temperature equal to or greater than the
08 value obtained from the expression:

09

$$10 \quad \text{temperature (deg F)} = 238 - 2.16X.$$

11

12 One example of these copolymers are ethylene-methyl acrylate
13 copolymers having a methyl acrylate content of Y weight
14 percent, Y being 20 or more and being based on the total
15 weight of ethylene and methyl acrylate in the copolymer, the
16 copolymer having an average melt-point temperature equal to
17 or greater than the value obtained from the expression:

18

$$19 \quad \text{temperature (deg F)} = 248 - 2.9Y.$$

20

21 Another example of these copolymers are ethylene-butyl
22 acrylate copolymers having a butyl acrylate content of Z
23 weight percent, Z being 20 or more and based on the total
24 weight of ethylene and butyl acrylate in the copolymer, the
25 copolymer having an average melt-point temperature equal to
26 or greater than the value obtained from the expression:

27

$$28 \quad \text{temperature (deg F)} = 240 - 2.1Z.$$

29

30 These high melt point ethylene-alkyl acrylate copolymers can
31 be made by a process comprising:

32

33

34

- 6 -

- 01 A. feeding overall an amount by weight, A, of alkyl
02 acrylate and an amount by weight, E, of ethylene to
03 a multi-zoned polymerization reactor;
04
05 B. introducing an effective amount of an initiator and
06 at least a portion, E_1 , of the total amount of
07 ethylene into a first reaction zone of the reactor;
08
09 C. concurrently introducing a portion, A_1 , of alkyl
10 acrylate to said first reaction zone such that (1)
11 greater than about 55% of the overall amount of
12 alkyl acrylate is introduced into said first
13 reaction zone, (2) the amount, A_1 , of alkyl
14 acrylate fed to said first reaction zone is greater
15 than the total amount of alkyl acrylate fed to all
16 subsequent reaction zones, and (3) the ratio of A_1
17 to E_1 in said first reaction zone is equal to or
18 greater than the ratio of A to E for the reactor
19 overall; and
20
21 D. feeding any remaining portions of initiator,
22 ethylene and alkyl acrylate to a subsequent
23 reaction zone or zones.
24

25 Preferably, the ratio of E_1 to E is between about 0.25 and
26 about 0.75, more preferably about 0.50, and the ratio of A_1
27 to E_1 is preferably greater than 1.2, more preferably
28 greater than 1.4 times the ratio of A to E.
29

30 Another process for the preparation of these high-melting
31 ethylene-alkyl acrylate copolymers comprises introducing to
32 a first reaction zone in a multi-zone reactor, initiator,
33 ethylene and a quantity of an alkyl acrylate which is (1) in
34 excess of 50% of the amount of alkyl acrylate fed overall to

01 the reactor and (2) greater than the total amount of alkyl
02 acrylate fed to all subsequent reaction zones, said quantity
03 of alkyl acrylate being effective to increase the average
04 melt-point temperature of said copolymers at least about 8°F
05 over the melt-point temperature of a copolymer having the
06 same alkyl acrylate content by weight as said produced
07 copolymer and made by introducing about 50% of the alkyl
08 acrylate fed overall to the reactor to said first reaction
09 zone and about 50% of the ethylene fed overall to the
10 reactor to said first reaction zone.

11

12 These processes are described in greater detail below. As
13 used herein, the following terms have the following
14 meanings:

15

16 1. "A" is used herein to denote the total amount by
17 weight of alkyl acrylate fed to the reactor.

18

19 2. "A₁" is used to denote the portion of the amount A
20 which is fed to first reaction zone in said
21 reactor.

22

23 3. "E" is used to denote the total amount by weight
24 ethylene fed to the reactor.

25

26 4. "E₁" is used to denote the portion of the amount E
27 which is fed to the first reaction zone.

28

29 One appropriate measure of these amounts is pounds (mass).

30

31 5. "First reaction zone" refers to the area in a
32 reactor where ethylene and alkyl acrylate come into
33 contact under polymerization conditions, and a
34 substantial amount of polymerization occurs.

01 However, the "first reaction zone" need not be the
02 first in a sequence of zones in the reactor. For
03 example, ethylene and/or alkyl acrylate could be
04 introduced into a zone of the reactor prior to the
05 "first reaction zone," but if no significant
06 polymerization occurs in this prior zone (e.g.,
07 less than about 5% of the total reaction takes
08 place), this zone is not considered herein to be
09 the "first reaction zone."
10

11 6. "Reaction zone" refers to an area within a single
12 reaction vessel in which polymerization of the
13 ethylene and/or alkyl acrylate takes place.
14 Typically, the "reaction zone" is a portion of a
15 single reaction vessel which is segregated from
16 other areas of the same reaction vessel. This
17 segregation can be accomplished by physical
18 barriers (such as baffles and the like), or other
19 suitable means (such as the mixing patterns within
20 the reaction vessel). As used herein, the term
21 "reaction zone" also includes areas in separate,
22 multiple reaction vessels where polymerization
23 occurs. Although multiple reactors may be used, in
24 one preferred embodiment, the process uses a
25 multi-zoned, high-pressure autoclave reactor. A
26 4-zone reaction system is preferred and is
27 exemplified in Figure 1, although additional zones,
28 such as six, or fewer zones, such as two zones, can
29 be used.
30

31 This process starts by feeding ethylene gas under high
32 pressure to the reactor.
33
34

01 Preferably, the ethylene is fed into the top of the reactor
02 and into Reaction Zone 1. The reactor zones are numbered
03 from top to bottom. Alkyl acrylate monomer is fed to the
04 reactor in an overall amount by weight of A pounds, and is
05 divided to feed selected zones. In one embodiment, Zone 1
06 is fed A_1 pounds, and Zone 2 is fed $(A - A_1)$ pounds.

07

08 In a continuous process the total feed of alkyl acrylate
09 relative to the total ethylene feed determines the alkyl
10 acrylate content of the final copolymer. A copolymer
11 containing 20 wt% alkyl acrylate has a smaller total feed
12 ratio of alkyl acrylate to ethylene (A/E) than a copolymer
13 containing 30 wt% alkyl acrylate. To achieve the desired
14 product, an overall A/E feed ratio is chosen and generally
15 maintained throughout a production run, although the ratio
16 A/E can be varied over time to produce copolymers containing
17 different weight percentages of alkyl acrylate.

18

19 The ratio of the amount by weight of alkyl acrylate monomer
20 to the amount by weight of ethylene monomer in a first
21 reaction zone (A_1/E_1) relative to the ratio of the overall
22 amount by weight of alkyl acrylate monomer to the overall
23 amount by weight of ethylene monomer (A/E) is critical to
24 obtain the improved properties of this type of
25 ethylene-alkyl acrylate copolymer. If the ratio A_1/E_1 is
26 equal to or greater than the overall ratio A/E required to
27 make the ethylene-alkyl acrylate copolymer, and if A_1 is at
28 least about 55% of A and exceeds the amount of alkyl
29 acrylate, if any, fed to all subsequent zones, then the
30 melt-point temperature of the copolymer is significantly
31 increased over conventional copolymers having the same alkyl
32 acrylate content.

33

34

- 10 -

01 In one preferred embodiment of this process, the ethylene,
02 E, fed to the 4-zone is divided so that E_1 , the amount of
03 ethylene in a first reaction zone (in this case, Zone 1), is
04 about 25% to 75%, and, more preferably, about 50%, of E.
05 About 75% to 25%, and more preferably about half, of the
06 ethylene monomer is fed into Zone 2. A_1 is controlled such
07 that A_1 is greater than 55%, preferably at least 70%, of A
08 and such that the ratio A_1/E_1 is equal to or greater than
09 the ratio of A/E. Preferably, the ratio A_1/E_1 is greater
10 than about 1.4, and more preferably is in excess of 1.8,
11 times the ratio A/E. Most preferably, all of the alkyl
12 acrylate is added to the first reaction zone in order to
13 attain ethylene-alkyl acrylate copolymers having the highest
14 melt-point temperatures.

15

16 The preferred temperature in the first reaction zone is
17 about 300°F to 450°F, and more preferably is about 325°F to
18 425°F.

19

20 High pressures are preferred when producing these high
21 melting ethylene-alkyl acrylate copolymers. The reaction
22 zone pressure preferably is about 10,000 to about 40,000
23 psig, more preferably about 15,000 to about 35,000 psig, and
24 most preferably is about 20,000 to about 30,000 psig.

25

26 A free radical initiator is preferably used to catalyze the
27 polymerization. The initiator can be added into any zones
28 where polymerization is desired. The initiator preferably
29 is fed into at least the first reaction zone in a sufficient
30 amount and rate whereby the temperature of the liquid phase
31 in the reaction zone is controlled in the range specified
32 above.

33

34

- 11 -

01 The initiator may be added to the reaction zone(s) in any
02 suitable manner. Generally, it is dissolved in a suitable
03 solvent, typically a hydrocarbon, and injected into the
04 zone(s). Normally, the initiator and alkyl acrylate are
05 simultaneously injected into the reaction zone(s), though
06 this is not essential. In a preferred embodiment, the
07 initiator and alkyl acrylate are simultaneously injected
08 into the reaction zone via concentric tubes, one carrying
09 the initiator and the other carrying the alkyl acrylate.

10

11 Examples of initiators include, peroxides such as lauroyl
12 peroxide, t-butyl perbenzoate, t-butyl peroxyvalate and
13 di-t-butyl peroxide. A preferred initiator is t-butyl
14 peroxyvalate. Typically, the initiator is dissolved in a
15 liquid hydrocarbon such as hexane or mineral oil.

16

17 In preparing the high-melting ethylene-alkyl acrylate
18 copolymers, is desirable to add an oxygen scavenging
19 compound to the reaction mixture. Phenolic compounds are
20 useful in this regard. These phenolic compounds include
21 2,6-di-t-butyl-4-methylphenol (BHT) and 2,6-
22 di-t-butyl-4-ethylphenol (BHEB). These compounds are well
23 known in the art; see U.S. Patent No. 3,941,747, issued
24 March 2, 1976 to Roth et al., which is incorporated herein
25 by reference. A preferred compound is BHEB. The addition
26 of the oxygen scavenging compound is at a rate such that the
27 concentration of the compound is preferably 0.01 to 0.5,
28 more preferably 0.05 to 0.10 wt%, of the total copolymer
29 produced.

30

31 The reaction mixture is agitated within the first reaction
32 zone to produce both radial and longitudinal mixing.
33 Preferably a substantially uniform reaction temperature is
34 maintained.

- 12 -

01 The reaction mixture proceeds from the first reaction zone
02 into a second reaction zone. The reaction mixture in the
03 second zone preferably is agitated to produce good radial
04 and longitudinal mixing. Preferably, the remaining alkyl
05 acrylate monomer, ethylene and additional free radical
06 initiator are introduced into the second reaction zone.
07 Also preferably, the three components are added separately.
08 The initiator is fed into the second reaction zone in a
09 sufficient amount and rate whereby the temperature of the
10 liquid phase in the final reaction zone is controlled to
11 about 350°F to 450°F, more preferably to about 350°F to
12 425°F, and most preferably 375°F to 425°F.

13

14 Preferably, there are one or more reaction zones after the
15 second reaction zone which are used to further polymerize
16 the ethylene and alkyl acrylate monomers. The reaction
17 mixture is removed from the end of Zone 2 (the second
18 reaction zone, in this case) and introduced into, e.g., two
19 additional reaction zones, where the mixture is agitated to
20 produce both radial and end-to-end mixing.

21

22 The amount of alkyl acrylate in the compositions of the
23 present invention has been found to be critical in two
24 respects. First, the overall amount of alkyl acrylate in
25 the composition must be from about 10 to about 25 percent by
26 weight of the composition, based on the combined weight of
27 the propylene-ethylene copolymer and ethylene-alkyl acrylate
28 copolymer. However, it has been found that it is not enough
29 simply to provide compositions with this amount of alkyl
30 acrylate in order to make films which have good RF sealing
31 properties. Instead, it has been found that the ethylene-
32 alkyl acrylate copolymer used in the compositions must
33 contain a minimum amount of alkyl acrylate, i.e., at least
34 about 20 weight percent alkyl acrylate. Thus, it has been

- 13 -

01 found that it is not sufficient to merely provide a
02 composition containing a minimum amount of alkyl acrylate
03 (as by making a composition containing a large amount of
04 ethylene-alkyl acrylate copolymer which, in turn, contains a
05 very small amount of alkyl acrylate), but rather the alkyl
06 acrylate must be concentrated in an ethylene-alkyl acrylate
07 copolymer containing relatively large amounts of alkyl
08 acrylate (e.g., 20 weight percent or more).

09
10 It is apparent from the foregoing discussion of the amount
11 of alkyl acrylate in both the ethylene-alkyl acrylate
12 copolymer and the overall composition that the relative
13 proportions of the propylene-ethylene copolymer and
14 ethylene-alkyl acrylate copolymer will depend upon the alkyl
15 acrylate content of the particular ethylene-alkyl acrylate
16 copolymer employed. Thus, for example, more of an ethylene-
17 alkyl acrylate copolymer containing about 20 weight percent
18 alkyl acrylate would be necessary to satisfy the requirement
19 that the overall composition contain about 10 to 25 weight
20 percent alkyl acrylate than would be required for an
21 ethylene-alkyl acrylate copolymer containing, e.g., 30
22 weight percent alkyl acrylate. Typically, the compositions
23 of this invention contain at least about 20 weight percent,
24 based on the combined weight of the propylene-ethylene
25 copolymer and ethylene-alkyl acrylate copolymer, of
26 propylene-ethylene copolymer, with the balance being
27 ethylene-alkyl acrylate copolymer containing sufficient
28 alkyl acrylate to satisfy the requirement of about 10 to
29 about 25 weight percent alkyl acrylate, based on the
30 combined weight of the propylene-ethylene copolymer and
31 ethylene-alkyl acrylate copolymer.

32
33 In one preferred embodiment of this invention, compositions
34 are provided comprising a propylene-ethylene copolymer and

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01 an ethylene-alkyl acrylate copolymer wherein the ethylene-
02 alkyl acrylate copolymer comprises about 20 to about 25
03 weight percent alkyl acrylate, and the percent by weight of
04 alkyl acrylate, based on the combined weight of the
05 propylene-ethylene copolymer and ethylene-alkyl acrylate
06 copolymer, is at least about 15. In another preferred
07 embodiment, the present invention provides such compositions
08 wherein the alkyl acrylate content of the propylene-ethylene
09 copolymer is about 25 weight percent and the weight percent
10 alkyl acrylate, based on the weight of propylene-ethylene
11 copolymer and ethylene-alkyl acrylate copolymer, is at least
12 about 10.

13
14 The compositions of the present invention may be made simply
15 by blending the propylene-ethylene and ethylene-alkyl
16 acrylate copolymers until a uniform mixture is achieved.
17 This may be accomplished by techniques well known in the
18 polymer arts, such as by blending in mechanical mixers like
19 a Brabender Plasticorder, a roll mill, a single or multiple
20 screw extruder or any of the other well-known mechanical
21 mixing equipment normally used in the mixing, compounding,
22 processing or fabrication of low or high molecular weight
23 thermoplastic, elastomeric or thermosetting polymers or
24 mixtures thereof. Preferably, the mixing is conducted at a
25 temperature high enough for the propylene-ethylene copolymer
26 and ethylene-alkyl acrylate copolymer to be in a deformable,
27 e.g., molten, state, but low enough that the polymers are
28 not degraded during mixing. A typical mixing temperature
29 would be in the range of from about 400°F to about 450°F.

30
31 Likewise, the compositions of this invention may be formed
32 into films by a variety of techniques known in the film
33 making art. One preferred manner of making films from the
34 compositions of this invention is by standard blown film

- 15 -

01 extrusion techniques, although conventional cast film
02 extrusion, sheet extrusion and calendaring techniques may be
03 used as well.

04

05 When the compositions of this invention are made into thin
06 films, such as films which are 4 mils thick, the films have
07 several beneficial properties. First, the films are RF
08 sealable using lower frequencies and less power than, for
09 example, films made from blends of polypropylene
10 (homopolymer) and an ethylene-alkyl acrylate copolymer (see
11 Table I below). These 4 mil films provide excellent RF
12 seals at about 27.2 MHz frequency and about 1.1 KW/inch²
13 power for about 1.5 seconds, as opposed to the unsealable
14 (by RF sealing) films made from a polypropylene
15 homopolymer/ethylene-alkyl acrylate copolymer blend.

16

17 In addition, the 4 mil films have excellent flexibility,
18 especially at low temperatures. This is especially useful
19 in applications, such as blood bags, where the film will be
20 subjected to extremely low temperatures (e.g., -35°C Red
21 Cross Standard), yet must remain flexible.

22

23 The films of this invention also possess other good
24 properties, such as optical and physical properties. For
25 example, the films of this invention have about 20% haze,
26 tensile strength greater than 3,300 psi and greater than
27 700% elongation. In addition, the films of this invention
28 are typically autoclavable at 120°C for 0.5 hour without
29 deleterious effects.

30

31 Presently, the standard bags for storing blood are made from
32 poly(vinyl chloride). These PVC bags, however, can crack
33 and break at the very low temperatures at which blood is
34 typically stored. Also, the PVC used to make these blood

- 16 -

01 bags has a density of about 1.26-1.3, and the PVC film used
02 to make the blood bags is about 14 mils thick. In contrast,
03 the compositions of the present invention have a density of
04 only about 0.93, representing a weight savings of about 30%
05 compared to PVC.

06

07 The compositions of this invention also have advantages over
08 compositions containing polypropylene (homopolymer) and
09 ethylene-alkyl acrylate copolymers ("PP/EAA") and
10 compositions containing polypropylene (homopolymer) and
11 ethylene-vinyl acetate copolymer ("PP/EVA"). For example,
12 films made from the PP/EAA compositions do not RF seal as
13 well as the compositions of this invention. The
14 compositions of this invention also contain fewer
15 extractables than do the PP/EVA compositions, and they
16 provide films with better clarity than the PP/EVA
17 compositions. In addition, residual vinyl acetate in PP/EVA
18 blends can cause a pH shift in the contents (e.g., blood,
19 plasma, etc.) of bags made from such blends.

20

21 The present invention is illustrated by the following
22 examples, which are not intended to be limiting on its scope
23 in any way.

24

25

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- 17 -

EXAMPLE 1

01

02

03 The blends shown in Table I below were made, each in turn,
04 in a ZSK-40 40mm Werner Pfleiderer twin screw compounder.
05 Operating conditions for the compounder were as follows:

06

07	Screw speed (RPM)	350
08	Torque (%)	60-75
09	Throughput (pph)	200
10	Die pressure (psi)	260-280
11	Vacuum (inches)	27
12	Melt temperature (°C)	223
13	Barrel temperatures (°C)	
14	Zone 1	190
15	Zone 2	200
16	Zone 3	200
17	Zone 4	200
18	Zone 5	200
19	Zone 6	210
20	Zone 7	210

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TABLE I												
BLEND COMPOSITIONS												
	BLEND NO.											
BLEND COMPONENT ¹	1	2	3	4	5	6	7	A	B	C	D	E
Propylene-ethylene copolymer	20	40	20	40	20	40	60	60	60			
Polypropylene										20	40	60
EMAC (20% MA, M.I. = 2)			80	60	80	60	40		40			
EMAC (20% MA, M.I. = 0.5)	80	60						40		80	60	40
EMAC (27% MA, M.I. = 2)												
Methyl acrylate content wt. % ²	16	12	16	12	22	16	11	8	8	16	12	8

¹ Numbers indicate weight percent.

² Weight percent of methyl acrylate based on total blend weight.

EXAMPLE 3

Blown films were made by conventional techniques using each in turn the blends described in Table I above. The films were 4 mils thick. The RF sealing properties of these films were tested with the results shown in Table II below.

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TABLE II												
RF SEAL PROPERTIES												
	FILM FROM BLEND NO.											
RF SEAL CONDITIONS ^a	1	2	3	4	5	6	7	A	B	C	D	E
RF Seal, Preheat time, sec.	0.7	WNS ^b	0.7	WNS	0.5	0.7	0.7	WNS	WNS	0.5	WNS	WNS
RF Seal, Weld time, sec.	1.2	WNS	1.5	WNS	0.5	1.5	1.7	WNS	WNS	1.7	WNS	WNS
RF Seal, Dwell time, sec.	1.0	WNS	1.0	WNS	2.0	1.0	1.0	WNS	WNS	2.0	WNS	WNS
RF Seal, Cycle time, sec.	2.2	WNS	2.5	WNS	2.5	2.5	2.7	WNS	WNS	3.7	WNS	WNS

^a 27.2 MHz, 12.5 KW sealing unit at 20% power, 3 inch annular die (2.22 inch² of sealing area), 0.026 inch NEMA XXXP buffer, 100 psi air pressure, ambient (unheated die).

^b WNS indicates that film would not seal.

The film properties of these films were also tested, with the results indicated in Table III below.

TABLE III

	1	2	3	4	5	6	7	A	B	C	D	E
Haze, %	12	17	22	16	27	24	19	16	13	18	27	32
Gloss	61	47	61	51	42	49	49	43	51	41	36	31
Clarity, %	1	0	1	0	0	0	0	0	0	0	0	0
MD Tensile Strength, psi	4000	4800	3300	4500	2500	3700	3400	4900	5000	3800	5000	4900
TD Tensile Strength, psi	3900	4300	3000	4500	2000	3400	3300	4100	4400	3700	4000	4000
MD Tensile Yield, psi	---	1800	---	2300	---	1500	1400	2400	2600	---	2200	2300
TD Tensile Yield, psi	---	1600	---	2200	---	1300	1300	2300	1700	---	1900	2000
MD Elongation, %	655	695	625	690	740	730	705	730	730	625	720	680
TD Elongation, %	705	700	630	720	700	810	720	695	735	645	690	680
MD Elmendorf Tear, gm/mil	200	150	300	80	280	160	170	60	80	210	80	80
TD Elmendorf Tear, gm/mil	230	330	190	60	160	210	190	70	50	190	110	120
MD 1% Secant Modulus, mpsi	20	46	23	64	19	41	41	66	77	26	64	64
TD 1% Secant Modulus, mpsi	17	40	16	60	8	31	29	63	68	21	55	55
Coefficient of Friction	>2.00	1.47	1.94	0.87	>2.00	1.50	1.45	0.94	0.42	1.70	0.96	0.90

The cast film is oriented in one direction as it is made. MD refers to the direction of orientation; TD refers to the direction traverse to the direction of orientation.

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02 WHAT IS CLAIMED IS:

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04 1. A composition comprising:

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06 A. a propylene-ethylene copolymer comprising about 1 to
07 about 7 weight percent ethylene; and

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09 B. an ethylene-alkyl acrylate copolymer comprising at
10 least about 20 weight percent alkyl acrylate,

11

12 wherein the percent by weight of alkyl acrylate, based
13 on the weight of A and B, is from about 10 to about 25.

14

15 2. The composition of Claim 1 wherein the propylene-
16 ethylene copolymer comprises about 1 to about 5 weight
17 percent ethylene.

18

19 3. The composition of Claim 1 wherein the propylene-
20 ethylene copolymer comprises about 2 to about 2.5 weight
21 percent ethylene.

22

23 4. The composition of Claim 1 wherein the propylene-
24 ethylene copolymer comprises about 2.2 weight percent
25 ethylene.

26

27 5. The composition of Claim 1 wherein the ethylene-alkyl
28 acrylate copolymer comprises about 20 to about 25 weight
29 percent alkyl acrylate, and the percent by weight of
30 alkyl acrylate based on the weight of A and B is at
31 least about 15.

32

33 6. The composition of Claim 1 wherein the ethylene-alkyl
34 acrylate copolymer comprises about 25 weight percent

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- 01 alkyl acrylate, and the percent by weight of alkyl
02 acrylate based on the weight of A and B is at least
03 about 10.
04
- 05 7. The composition of Claim 1 wherein the ethylene-alkyl
06 acrylate copolymer is an ethylene-methyl acrylate
07 copolymer.
08
- 09 8. The composition of Claim 3 wherein the ethylene-alkyl
10 acrylate copolymer is an ethylene-methyl acrylate
11 copolymer.
12
- 13 9. The composition of Claim 5 wherein the ethylene-alkyl
14 acrylate copolymer is an ethylene-methyl acrylate
15 copolymer.
16
- 17 10. The composition of Claim 6 wherein the ethylene-alkyl
18 acrylate copolymer is an ethylene-methyl acrylate
19 copolymer.
20
- 21 11. The composition of Claim 1 wherein the ethylene-alkyl
22 acrylate copolymer has an average melt-point temperature
23 equal to or greater than the value obtained from the
24 expression:
25
- 26
$$\text{temperature (deg F)} = 238 - 2.16X$$

27
- 28 wherein X is the alkyl acrylate content of the ethylene-
29 alkyl acrylate copolymer.
30
- 31 12. The composition of Claim 8 wherein the ethylene-alkyl
32 acrylate copolymer is an ethylene-methyl acrylate
33 copolymer having an average melt-point temperature equal
34

- 23 -

01 to or greater than the value obtained from the
02 expression:

03

04 $\text{temperature (deg F)} = 248 - 2.9Y$

05

06 wherein Y is the methyl acrylate content of the
07 ethylene-methyl acrylate copolymer.

08

09 13. A film made from a composition comprising:

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11 A. a propylene-ethylene copolymer comprising about 1 to
12 about 7 weight percent ethylene; and

13

14 B. an ethylene-alkyl acrylate copolymer comprising at
15 least about 20 weight percent alkyl acrylate,

16

17 wherein the percent by weight of alkyl acrylate, based
18 on the weight of A and B, is from about 10 to about 25.

19

20 14. The film of Claim 13 wherein the propylene-ethylene
21 copolymer comprises about 1 to about 5 weight percent
22 ethylene.

23

24 15. The film of Claim 13 wherein the propylene-ethylene
25 copolymer comprises about 2 to about 2.5 weight percent
26 ethylene.

27

28 16. The film of Claim 13 wherein the propylene-ethylene
29 copolymer comprises about 2.2 weight percent ethylene.

30

31 17. The film of Claim 13 wherein the ethylene-alkyl acrylate
32 copolymer comprises about 20 to about 25 weight percent
33 alkyl acrylate, and the percent by weight of alkyl

34

01 acrylate based on the weight of A and B is at least
02 about 15.

03

04 18. The film of Claim 13 wherein the ethylene-alkyl acrylate
05 copolymer comprises about 25 weight percent alkyl
06 acrylate, and the percent by weight of alkyl acrylate
07 based on the weight of A and B is at least about 10.

08

09 19. The film of Claim 13 wherein the ethylene-alkyl acrylate
10 copolymer is an ethylene-methyl acrylate copolymer.

11

12 20. The film of Claim 15 wherein the ethylene-alkyl acrylate
13 copolymer is an ethylene-methyl acrylate copolymer.

14

15 21. The film of Claim 17 wherein the ethylene-alkyl acrylate
16 copolymer is an ethylene-methyl acrylate copolymer.

17

18 22. The film of Claim 18 wherein the ethylene-alkyl acrylate
19 copolymer is an ethylene-methyl acrylate copolymer.

20

21 23. The film of Claim 13 wherein the ethylene-alkyl acrylate
22 copolymer has an average melt-point temperature equal to
23 or greater than the value obtained from the expression:

24

25
$$\text{temperature (deg F)} = 238 - 2.16X$$

26

27 wherein X is the alkyl acrylate content of the ethylene-
28 alkyl acrylate copolymer.

29

30 24. The film of Claim 23 wherein the ethylene-alkyl acrylate
31 copolymer is an ethylene-methyl acrylate copolymer
32 having an average melt-point temperature equal to or
33 greater than the value obtained from the expression:

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- 25 -

01 temperature (deg F) = 248 - 2.9Y

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03 wherein Y is the methyl acrylate content of the
04 ethylene-methyl acrylate copolymer.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 93/11456

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: C08L 23/16, C08L 23/08, C08L 33/08
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: C08L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE, A1, 2733470 (BASF AG), 15 February 1979 (15.02.79)	1,13
A	US, A, 3555110 (R. L. MCCONNELL ET AL), 12 January 1971 (12.01.71).	1,13
A	US, A, 4234656 (A AMEMBAL ET AL), 18 November 1980 (18.11.80)	1

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
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- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

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X document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

G document member of the same patent family

Date of the actual completion of the international search

7 March 1994

Date of mailing of the international search report

25.03.94

Name and mailing address of the International Searching Authority



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INTERNATIONAL SEARCH REPORT

SA 2867

Information on patent family members

28/01/94

International application No.

PCT/US 93/11456

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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US-A- 3555110	12/01/71	NONE	
US-A- 4234656	18/11/80	CA-A- 1121543	06/04/82
		EP-A- 0013084	09/07/80
		JP-A- 55084339	25/06/80

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